

Model to Assess Impacts on Fleet-Wide Energy Use from Multi-Modal Opportunities Freight Fleet-Level Energy Estimation Tool (FFLEET)

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Overview

Timeline

- Project start: Oct 2016
- Project end: Sept 2019
- Percent complete: 20%

Budget

- Total DOE funding: \$525k
- FY 2017: \$175k

Partners

- Project lead: ORNL
- National Renewable Energy Laboratory (NREL)
- UPS

Barriers

- Lack of understanding of energy savings benefits from fleet-level implementation of Smart Mobility technology options and modal choices by shippers
- Risk averse industry: truck manufacturers and fleets are reluctant to introduce and invest in new technologies with uncertainty in energy savings potential

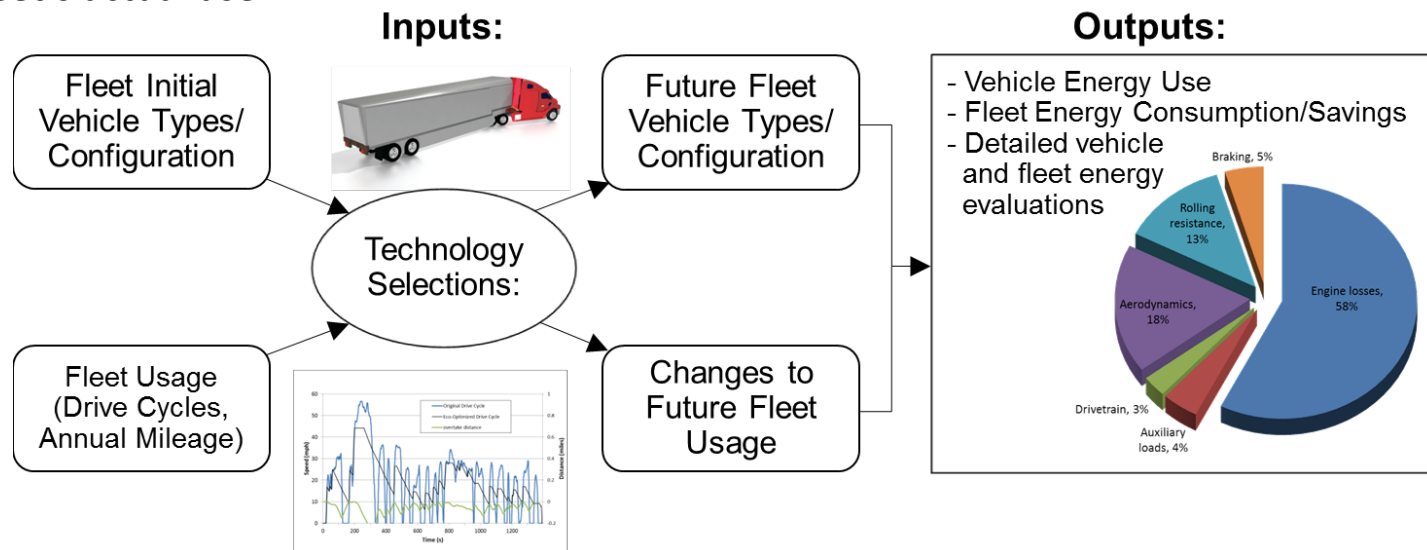
Relevance

Objectives

- Develop the Freight Fleet-Level Energy Estimation Tool (FFLEET), a user-friendly, web-based model that will allow trucking fleets to estimate the energy savings due to Smart Mobility systems, alternative fuel technologies and freight modal shifts

Impact

- FFLEET will allow trucking fleets to **quantify energy savings at the fleet level** associated with Smart Mobility technologies
- Allows energy comparisons between the current fleet and scenarios for future deployment of advanced vehicle technologies and modal shifts
- Accelerate energy efficiencies across fleets and prioritize the most effective technologies based on the fleet's actual use



Approach

- The FFLEET model is designed with the following features:
 - Full-fleet evaluation
 - Physics-based vehicle model: tractive power and efficiency analysis
 - Enables energy savings to be quantified from advanced vehicle technologies, either individually or in combinations
 - To simplify the fleet profile creation, selections of the vehicle specification and usage are automated as much as possible
 - Selected technologies modeled via influence on primary vehicle parameters and modification to drive cycles
 - Several user options to select/identify relevant drive cycles, including GIS based analysis to determine road speed and grade from routes
 - Smart Mobility as well as other advanced technologies, such as aerodynamic reduction devices, low rolling resistance tires, hybrid systems, etc.
- Collaboration with UPS to perform an assessment at its newly renovated midwest distribution center in Columbus, Ohio

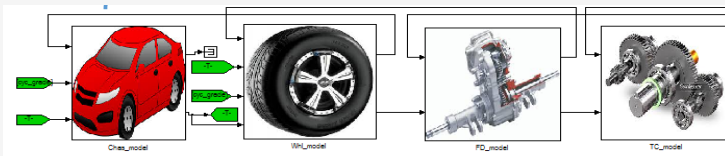
Technologies Available for Evaluation in FFLEET

Vehicle types	Powertrain types	CAV technologies	Other fuel efficiency technologies
Class 7-8 tractor-trailers (day cabs and sleeper cabs)	Conventional internal combustion engine (gas, diesel, or natural gas)	Traffic signal eco-approach and departure	Aerodynamic drag reduction devices (advanced cabin fairings, trailer skirts, boat tails, trailer gap reduction, under body drag reduction, wheel covers)
Box/straight trucks (refrigerated or not)	High pressure direct injection (HPDI) engine (dual fuel natural gas-diesel)	Connected Eco-Driving	Low rolling resistance tires
Delivery/step vans	HEVs (series and parallel configurations)	Advanced cruise control technologies (ACC and CACC)	Speed limiters
Car carriers	PHEVs	Grade/traffic-based powertrain control and optimization (e.g. Intelligent Powertrain Management)	Auxiliary Power Units (APUs)
Flatbed trucks	BEVs		Advanced transmissions
Freight trains	Other all-electric vehicles, including catenary- or rail-powered	Platooning	Vehicle Lightweighting options (carbon fiber body panels, low mass glider, compacted graphite iron (CGI) block)

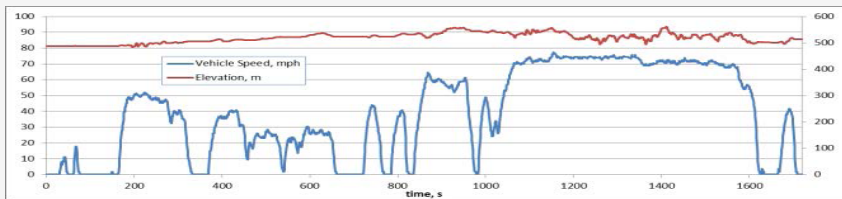
Creating the Fleet Profile in FFLEET

Vehicle configuration and usage specification

Vehicle Powertrain Specification



Drive Cycle Definition



Usage specification:

In addition to measured or regulatory cycle data, automated tools can estimate a drive cycle based on a specified route or travel within specified region, based on GIS analysis

Data entry simplified to shorten full-fleet profile creation

Automated entries for ease of use:

- Default parameters entered based on selected technologies, but user may modify entries if has more specific data
- Drive cycle impacts (CAV technologies) will be evaluated using sub-models that smooth the original drive cycle
- For passenger car models, a link will allow selection of the particular vehicle option from the fueleconomy.gov website

EV/Hybrid sizing options:

- Automated sizing of motor/battery for generic model, or detailed user specification

Vehicle library allows easy selection/ reuse of existing vehicles

- Many default vehicle types, and user can reuse and modify any model previously created

Vehicle configuration and relevant drive cycle data must be entered for each vehicle type and usage to specify the complete fleet profile



Technical Accomplishments and Progress

- Completed literature review (FY17Q1)
 - Assessed the capabilities, strengths and weaknesses of existing models for evaluating the fleet-level benefits associated with Smart Mobility and modal shifts
 - Most existing models not designed for full-fleet evaluations. Ease of use was determined to be a critical factor to enable fleet-level evaluations
- Tractive energy/vehicle efficiency model development is mostly complete (expected completion by May 2017)
- UPS agreed to provide fleet and vehicle operation data from Columbus for validation (NDA being processed) as well as feedback on model

Responses to Previous Year Reviewers' Comments

This project was not reviewed last year.

Collaboration & Coordination with other Institutions

- NREL collaboration, as part of the Smart Mobility Multi-Modal pillar research
 - Conducting research for drive cycle evaluations of fleets using the Fleet DNA database
 - Developing an approach to automatically create a drive cycle based on a selected route. Speed limit and history-based data will be used, along with typical speed variations obtained from Fleet DNA
- UPS Collaboration, NDA being developed
 - Better understanding of intended implementation of alternative freight transport modes and alternative fuel technologies (drones, EVs, PHEVs, etc.), including factors driving their selection
 - Vehicle operation data will be provided for model refinement/ validation purposes
 - UPS will provide feedback on FFLEET, providing guidance for future enhancements, additional features, etc.

Remaining Challenges and Barriers

- UPS has agreed to provide data on vehicle operations and modal selections in Columbus, but NDA is not finalized
- Analysis of CAV technologies (including platooning) will initially be completed using results from previous studies based on a literature survey. More relevant models that employ the vehicle and usage specifications are envisioned but require further input from the CAVs pillar

Proposed Future Research

- Model will be deployed as a web-based tool that fleets can easily use to evaluate advanced efficiency technologies, FY17Q3-4
- Evaluation of UPS operations at the Columbus, Ohio midwest distribution center will be performed as an initial demonstration of the tool. Expected completion later in FY17
- Impacts from CAV technology/platooning to be implemented/refined based on results from CAVs pillar in FY18

“Any proposed future work is subject to change based on funding levels.”

Summary

- The freight shipping industry is very conservative and risk averse, and truck manufacturers and fleets are reluctant to introduce and invest in new technologies with uncertainty in energy savings potential
- The FFLEET tool will enable trucking fleets to quantify the fleet-level energy savings due to Smart Mobility systems, alternative fuel technologies and freight modal shifts
 - Fleet managers can make comparisons of the energy consumption between the current fleet configuration and scenarios for future deployment of advanced vehicle technologies and modal shifts
 - Allows for planning and tracking of the energy benefits of advanced technologies and what-if evaluations
- To enable full-fleet evaluations, the tool is designed for maximum ease of use
 - Vehicle parameter default selections in the web-based tool will be made based on overall technology selections, while allowing the user to easily modify any values, and vehicle year/make/model selections will be available to fully specify passenger cars
 - A vehicle library will be available allowing complete vehicle specifications to be loaded easily, and any new vehicles created by the user will be saved to his personal library for modifications
 - For usage specification, the user can upload measured drive cycles, use standardized cycles from a library. Alternatively, a function is being developed so that usage can be automatically created by specifying a route or region, which is intended to simplify this task, particularly for users that are not very familiar with drive cycles and their importance for energy efficiency impacts